over 1,000 fathoms orange and mango leaves, sugar-cane, nutmegs, and land-shells in profusion, and many hermit-crabs actually inhabiting tubes of bamboo instead of shells. We found a land-crab once in 450 fathoms; no doubt it had drifted out hanging on to some floating object, and had sunk to the bottom, being unable to swim.

The numbers of animals to be found in the deep sea decrease rapidly in proportion as the depth exceeds 2,000 fathoms, and very probably the greatest depths have very little life in them. We at present know only of Rhizopods as inhabiting them. Even in depths of less than 2,000 fathoms the shallower waters are most productive, and probably the deep-sea fauna is most abundant not far from the upper limit of its range. It is here, in from 200 to 400 fathoms, that such forms as Pentacrinus are most numerous. Here in many places these animals, a few years ago the greatest of rarities, cover the sea-bottom, thickly set like trees in a forest, still as abundant as ever they were in geological times. It is probably scarcity in supply of food which limits the quantities of animals in great depths. No doubt food is always most abundant near the coasts.

Some animal forms appear to be dwarfed by deep-sea conditions of life. Others attain under them gigantic proportions. It is especially certain crustacea which exhibit this latter peculiarity, but not all crustacea, for the crayfish-like forms in the deep sea are of ordinary size. I have already referred to a gigantic Pycnogonid dredged by us. Mr. Agassiz dredged a gigantic Isopod eleven inches in length. We dredged also a gigantic Ostracod. The increase in size depends probably on lack of enemies rather than on abundance of food.

The unhappy deep-sea animals have not escaped their parasites in their cold and gloomy retreat. The tube of the Cerianthus, of which I showed a figure, was full of Nematode worms. Crinoids are beset by a Myzostomum, and one deep-sea shrimp was found with a parasitic Gordian worm coiled up inside its body, filling it almost entirely. I have already described the vegetable parasites of corals.

The existence of colour in deep-sea animals is a very interesting fact. Some of the animals, as for example many of the fish, have lost their colour in the dark, and have become simply black or white. Others are most brightly coloured, having retained through countless generations the colouring of their shallow-water ancestors. Some, like the deep-sea shrimps, which are almost always of an intensely bright red colour, seem to have developed a special amount of colouring in the depths. The phosphorescent light of deep-sea Alcyonarians, when examined by the spectroscope, is seen to consist of red, yellow, and green rays only. Hence only these colours would be effective in the deep sea, and no blue animals were dredged from any considerable depths.

Colouring matters however need not always have a decorative object in existence. Certain chemical compounds formed within the bodies of animals for various physiological purposes may happen to have a peculiar action on light so as to be coloured, but this colour-producing property may be a waste or bye-product, so to speak, and only be turned to advantage by certain animals as a subsequent improvement. The fact that our own blood is red is probably an instance in point. In most mammalia the blood is entirely in the dark throughout the animal's life, and never acts on the light so as to exhibit its colour, which is to these animals useless. In ourselves the colour has been turned to advantage for decorative purposes. The colouring matters of some deep-sea animals may thus be retained, because the substances yielding the colours are necessary for the well-being of the animals, and these substances happen to be coloured, just as sulphate of copper is blue, though chemists seldom employ it because of its colour.

As an example of the vividness of deep-sea colouring matters, may be cited that of Pentacrinus. Here (Fig. 17) is a Pentacrinus dredged from 400 fathoms near the Azores. The animal may be briefly described as a star-fish turned upside down and set on a stalk. When freshly dredged Pentacrini are put into spirit, their colouring matter dissolves out and tinges the spirit of an intense purple red. (The light was thrown upon the screen through a solution of this colouring matter in spirit, from specimens of Pentacrinus dredged in 650 fathoms.) The colour is a most beautiful red. It is red when acid, but when a few drops of ammonia are added to it, it turns to an intense green. Very probably this colouring matter is as ancient as the genus Pentacrinus itself.

The colouring matter yields a well-defined absorption spectrum. The acid solution (Fig. 18) shows two dark bands in the yellow and a faint one in the green, and the alkaline green fluid a dark one in the red, with two fainter

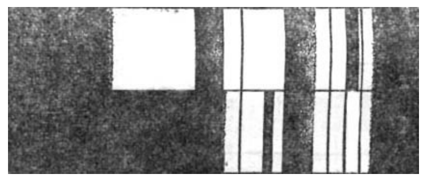

FIG. 18.—Spectra of the acid and alkaline solutions of the colouring matter of Pentacrinus in spirit The acid spectrum above and the alkaline below. The fine lines are solar lines.

ones in the yellow and green. By means of this double set of lines this colouring matter can be almost certainly identified, although its chemical composition has never been investigated.[1]

A good many other colouring matters of deep-sea animals give well-marked absorption spectra, and can be similarly identified, and it is most interesting to find that the very same colouring matters found in deep-sea animals occur also in allied shallow water and surface forms. Thus numerous deep-sea corals and sea-anemonies are tinged of a madder-red colour by the same pigment, which is abundant in many jelly-fish which float on the sea surface. The red colouring matter of the deep-sea shrimps is also identical with that which occurs in smaller quantities in nearly all the microscopic crustacea with which the sea surface is crowded.

In conclusion I would merely impress upon you again that the most important subject now remaining to be investigated with regard to deep-sea life is the range of life at the various depths between the surface and the bottom of the ocean.

A MAGNETO-ELECTRIC GYROSCOPE

THIS is the name of an apparatus invented by M. W. de Fonvielle, editor of *Electricité*, after having witnessed an experiment by M. D. Lontin. This gyroscopic machine was exhibited by M. de Fonvielle to the Royal Society on the 15th inst., when a paper by him was read by Prof. Stokes. The instrument can now be seen at Elliot's, St. Martin's Lane.

The object of the apparatus is to demonstrate new properties of induction currents brought into play in a magnetic field, and which give a continuous rotatory motion to movable pieces of iron of various forms (Fig. 1). The apparatus consists essentially of a galvanometric frame of any shape. In the first model which has been brought over to England the galvanometric frame is a rectangular one, above which is placed a horseshoe-magnet, supported by a vertical axis round which the

[1] See H. N. Moseley, "On the Colouring Matters of Various Animals, especially Deep-sea Forms" (*Quart. Journ. Micro. Sci.*, vol. xvii., new ser., p. 1).

magnet can be placed in any azimuthal position which may be required. The galvanometric frame has been so constructed that the the horseshoe-magnet may be taken away and be replaced by any number of bar-magnets laid flat upon its upper side. It is possible also to place other bar-magnets underneath the frame in a space arranged for that purpose, or to place the two magnets laterally, or on the left and right side of the frame (Fig. 2).

To produce a continuous movement of rotation with

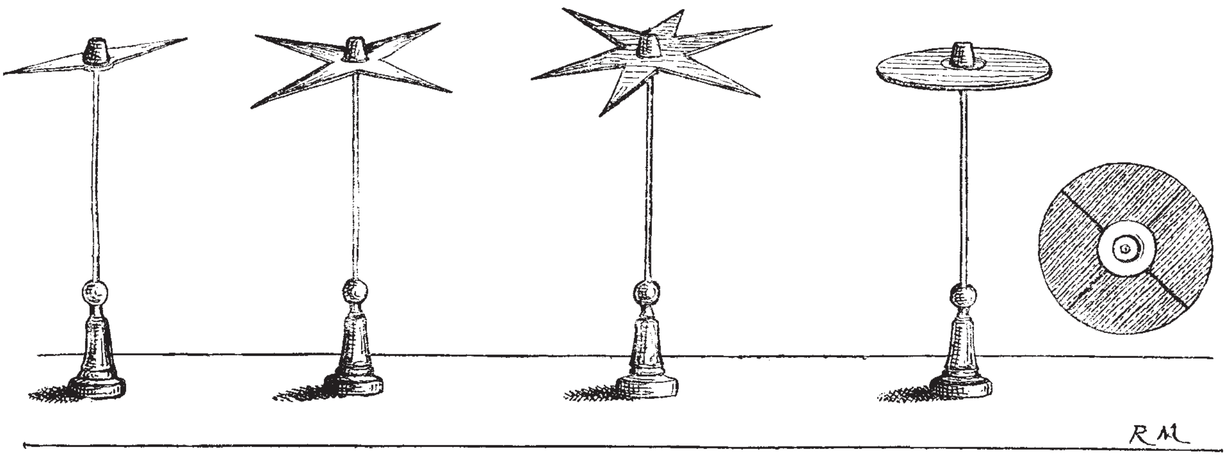

FIG. 1.—Some of the soft iron rotators used in the gyroscope.

the intervention of the magnets it is sufficient to place any movable piece of iron in equilibrium by means of a block on a vertical axis (Fig. 3) inside of the frame, and to send the current of induction into the coil. When, by

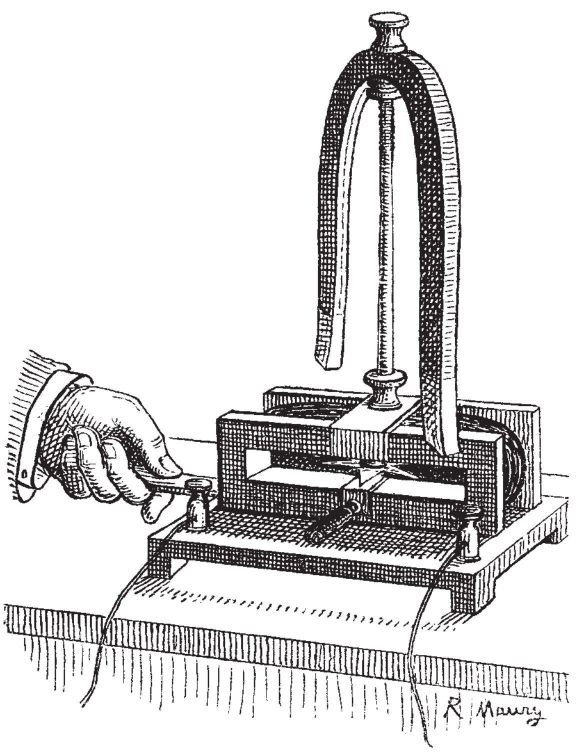

FIG. 2.—Rotating induction machine surmounted by a magnet. The operator is introducing a magnet into the space underneath the frame.

means of a commutator, the direction of the primary is changed, the direction of the motion of rotation is reversed. The same phenomenon is observed when we transfer the poles of the acting magnets from left to right, or *vice versâ*. But no sensible alteration even in the velocity is observed when we place the bar-magnets underneath which have been originally placed on the top, or *vice versâ*. If the magnets are too near or too far from the rotating piece of iron, the motion ceases, which, under favourable circumstances, might acquire a very great velocity. The rotation is also stopped when the magnets are placed in a direction perpendicular to the frame.

The movable piece may be placed also at a small distance laterally without the rotation ceasing to take place. It may be also placed on the top, and be rotated by the influence of the bar magnets placed underneath.

The same phenomena may be obtained very easily with a bar electro-magnet of which one pole is presented at a distance of several metres. In this case the experi-

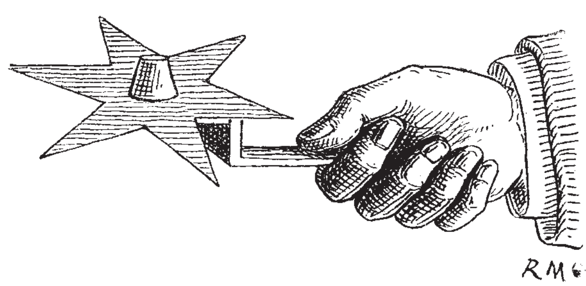

FIG. 3.—Movable piece balanced on its axis, ready to be introduced into the galvanometric frame.

ment is very curious, and looks like a conjuring trick, as two or three movables can be rotated at once. A mere change in the pole presented produces a change in the direction of rotation as well as the displacement from one side of the axis to another. But the operator must be careful not to approach too near, otherwise, the power of the electro-magnet being too great, the action of the induction-current is absorbed, and no motion at all is observed. If the operator is quite near, the movable pieces of iron are attracted magnetically, and fly from the pivots where they have been rotating, to the pole of the electro-magnet. To ascertain the velocity of the movable pieces of iron it is advisable to have them painted half in white and half in black, so that they

become grey as soon as the velocity is six or seven turns in a second.

It is possible also to obtain motion without the presence of magnets by guiding an impulse to the movable by an exterior force, and M. de Fonvielle and M. Lontin insisted on that particular point in the memoir they have presented jointly to the Paris Academy in offering a theory of these curious phenomena. The rotation is not always the same, but once it is determined in a solid sufficiently balanced it continues indefinitely in the same direction. The direction does not change when we reverse the direction of the currents by means of a commutator.

The possibility of producing the same movement by means of movables of any form whatever, in presence of magnets or without their action, and notably of two spirals constructed of a flat wire and wound in an opposite direction, appears to the inventors to demonstrate that the rotatory action is exercised individually on each molecule of iron, and that the total impulse must be regarded as the integral of the individual impulsive actions. This remarkable property appears to furnish a very simple means of completely explaining all the circumstances of these curious phenomena by means of the known laws of induction, and to dispense with having recourse to any new hypothesis. It is sufficient, in fact, to remark that the molecule of iron acts in its movement of rotation in two different ways in each of the two nearly equal currents of induction which successively traverse the spires. In fact, during the whole continuance of the two phases of rotatory movement which the galvanometric frame brings closer together, each molecule of soft iron increases the intensity of the current which affects it, and which the inventors call *positive*, independently of its real direction, in order to fix the idea; at the same time it diminishes that of the current which repels it, and which they call *negative*, for the same reasons. In the two other phases of its movement the same molecule diminishes the intensity of the positive current, which then tends to draw it back, and increases that of the negative current, which turns it away from the frame. The actions exerted in the two phases of the movement, that is, in the total extent of the plane described by the molecules, tend then to keep up the continuous rotation, which progressively increases in speed until it reaches that which corresponds to the absolute intensity of the attractions or repulsions exercised by the currents induced, by the energy of the inductive current, the value of the friction of the resistance of the arc, &c.

When we bring the pole of a magnet into action, it is clear that its influence determines in each of the molecules of the movable object a transient magnetisation which strengthens the induction currents produced in the spires in the cases in which it is concordant, and which paralyses them in the opposite case. It hence results that, in presence of a permanent magnetic centre, the movement is possible only in a direction determined by its position and its nature. MM. De Fonvielle and Lontin believe that this principle applies even to the action of the earth.

When we change the position of the active pole in relation to the axis of rotation, the rotation changes its direction; but the pole of the magnet may be placed above or below, to right or left, without the rotation changing its direction. The two poles of a bar or a horseshoe magnet combine to accelerate the movement when they are placed in the direction of the frame; but if we place the magnet in a perpendicular direction, all movement is, as a rule, rendered impossible. It is the same with near position; in proportion as we approach it to that limit of position, the rotation in general will be found to slacken. It is clear that a magnetisable body so strongly tempered as not to have the capacity of being magnetised and demagnetised to the given extent, will remain insensible to these successive dynamic reactions, and consequently immovable, and that it is necessary to employ the softest possible iron in the construction of the movable objects. The same phenomena, especially with the spiral, may evidently be produced if we place it about the frame. They are accompanied, especially with the full disk, by a strident sound, by alternate magnetisations and demagnetisations. Their production appears to the inventors a new confirmation of the theories which they have advanced.

We must add that the coil used is of a peculiar construction, but that at least some of the phenomena can be observed without any Ruhmkorff's machine at all, but with an interrupter of the current from the battery.

It is impossible to say at present if the apparatus may be rendered serviceable as a motive power. But it may be used at all events not only as exhibiting a new mode of action, but as a balance to make a comparison of the force of several magnets, by placing them in opposition at various distances.

NOTES

McGill University, Montreal, has long held the lead in the cultivation of natural science among the colleges of Canada, and has already large collections, which are still further to be increased by the liberality of Mr. Redpath, a member of the Board of Governors, and Principal Dawson. Mr. Redpath proposes to erect on the College grounds, and on a site which will harmonise with the arrangement of the existing buildings, a stately and beautiful edifice for a museum of geology and natural history, primarily for the use of the professors and students of the college, but also for the benefit of the public generally. The building is to be detached and practically fire-proof, and while it will be an ornament to the college grounds, will be fully up to the present idea of museum buildings in regard to space, light, and means for study and illustration. It will accommodate the whole of the present collections of the University, and will enable them for the first time to be fully accessible to students. In connection with Mr. Redpath's gift, Principal Dawson purposes to present to the University the whole of his private collections in geology, embracing the types of the species which have been described by him in his papers and other publications. In some departments of the geology of the Dominion, as in the fossils of the Pleistocene and Carboniferous, and in the geology of the Maritime Provinces, these collections are believed to be the most important ex ant.

The International Congress of Anthropology and Prehistoric Archæology holds its next meeting at Lisbon, on September 20–29, this year. Several important questions concerning the prehistoric archæology of Portugal will be discussed. Excursions will be made to several places of archæological interest.

A universal exhibition of prehistoric German anthropology will take place at Berlin in August. All the German States have been invited to join in this exhibition, which will comprise objects chosen from every museum in Germany. Prof. Virchow is at the head of the Committee appointed to organise the necessary details.

The Institution of Mechanical Engineers holds its ordinary general meeting to-day and to-morrow, April 23, at 7.30 p.m. The following papers will be read and discussed:—"Remarks on Chernoff's Papers on Steel," by Mr. William Anderson, of Erith; "On Permanent Way for Tramways, with special reference to Mechanical Traction," by Mr. J. D. Larsen, of London; "On Water-Pressure Engines for Mining Purposes," by Mr. Henry Davey, of Leeds; "On Electric Lighting" (second paper), by Dr. John Hopkinson, F.R.S., of I ondon